

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800

Open access books available

122,000

International authors and editors

135M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



# Rehabilitation of Patients Following Arthroplasty of the Hip and Knee

Magdalena Wilk-Frańczuk  
*Frycz-Modrzewski Cracow University,  
 Cracow Rehabilitation Center, Scanmed St. Rafael Hospital, Cracow  
 Poland*

## 1. Introduction

Arthroplasty (Latin *arthroplastica*) with endoprosthesis is a reconstructive procedure whose purpose is to restore the damaged joint by creating a substitute joint with actions similar to those of the physiological joint. The term “arthroplasty” is used interchangeably in the literature with “total joint replacement” or “alloplasty.”

There are several indications for arthroplasty, especially involving the large joints of the lower limbs, such as hip or knee, which are exposed to significant loads. Total joint replacement is mainly applied to joints damaged by a disease process (e.g. osteoarthritis). Arthroplasties are performed in people of all ages; however, elderly patients make up the majority. Primarily cemented or uncemented prostheses are implanted, rarely the so-called hybrid type, where only one element is embedded in bone cement. Regardless of the type of prosthesis, however, or its construction, the operated joint, or the surgical approaches used, as well as the patient's age, Body Mass Index (BMI), or general state of health, each patient needs an adequate rehabilitation protocol. This protocol should be instituted before surgery, or immediately after if the operation is performed on an emergency basis.

Since the application of the first prosthesis, there has been continuous progress in this field. This applies to the materials and design of the prostheses, the surgical techniques used, and post-operative rehabilitation. The largest differences relate to the point at which physiotherapy begins and (and perhaps most importantly) when the patient stands up and full weight is put on the joint. The physician, usually the orthopedic surgeon who performed the operation, makes the decision to implement rehabilitation. But the decision as to when to stand the patient up and the assessment of the load capacity of the operated limb also belong to physiotherapist.

Close interdisciplinary cooperation is always of great importance for the patient, in this case the patient after arthroplasty, who often requires an individual rehabilitation program (Grotle et al., 2010). This individualization involves some modifications of the general scheme of rehabilitation developed and used in orthopedic and rehabilitation centers. After standard operations, the early full loading of the operated limb gives much better post-operative results, and the patient regains functional capacity sooner. Outcome assessment should be monitored. Studies have used different research methods, including the functional evaluation of patients using different scales, such as the Harris scale, a 100-point

scale that assesses the quality of life especially of older patients, as well as the impact of various factors such as BMI on the healing process (Cichy et al., 2008; Dudda et al., 2010; Starowicz et al., 2005). In addition to standard physiotherapy assessment instruments, methods based on computer analysis use dedicated equipment and computer programs (e.g. stabilometry platforms, sEMG, strain gauge tests, photoelastic tests, pedobarography, and thermal tests – Burnfield et al., 2010; Cichy & Wilk, 2006; Cichy et al., 2008; Maguire et al., 2010; Wilk et al., 2004, 2008). This allows for more objective results, and also leads to the formulation of new ideas for modifying and optimizing patient rehabilitation programs.

## 2. Rehabilitation after hip arthroplasty

Arthroplasty with prosthesis, or total hip replacement with an artificial joint to replace the one that has been destroyed, has ushered in a new era in the treatment of degenerative arthritis. The occurrence of osteoarthritis seems to be a consequence of the European style of civilization, as it almost does not occur in India, Mexico, South America, Africa, or the Far East (except for Japan and Australia). In Poland, according to epidemiological studies by various authors, osteoarthritis affects approximately 10 to 20% of the population, and therefore between 4 and 8 million people, including approximately 4% between 18 and 34 years of age and up to 85% of people over the age of 75. From the clinical point of view, and in terms of frequency, osteoarthritis of the hip occupies a prominent place next to osteoarthritis of the knee and spinal joints. It is characterized by localized pain in the groin area, on the front or side of the thigh, and is often associated with radiating pain around the knee. These symptoms appear and worsen after exercise, or a longer walk, but often also occur at rest and at night. There is stiffness in the morning or after prolonged immobilization of the joint, and the dysfunction is often associated with swelling, limited range of motion, muscle weakness, and radiographic changes.

The etiology of osteoarthritis of the hip is easy to determine if the patient has a congenital or acquired defect during development, such as hip dysplasia, Perthes disease, or deformity of the femoral head. Some other factors that are easy to determine are adverse biochemical changes occurring in articular cartilage, or a dislocation or fracture within the joint in the past. Frequently, however, the cause of the disease remains difficult to establish, because degenerative-deforming hip joint diseases are not an homogeneous disease entity, but a complex of lesions arising as a result of different causal factors. Given the diversity of these factors, degenerative-deforming changes of the hip joints can be divided into two basic groups: - primary (idiopathic) coxarthrosis and secondary coxarthrosis. The first group includes patients diagnosed on the basis of clinical examinations, along with radiological and laboratory tests. and cannot be said to prove the root cause of the disease. The second group are patients with, for example, congenital or acquired hip disorders.

The diagnostic criteria for primary hip osteoarthritis adopted and published in 2000 by the American College of Rheumatology include pain in the joint and at least two of the three following symptoms: ESR <20 mm after 1 hour; edge or central osteophytes detected radiographically; joint space stenosis (Moody, 2000).

The degenerative process is irreversible. However, appropriately individualized and systematic conservative treatment helps to reduce pain, maintain range of motion, and increase muscle strength, thereby reducing disability and slowing the progression of the disease. This treatment involves the use of NSAIDs and analgesics, and an appropriate rehabilitation program, which consists of physical treatments, kinesitherapy, and if

necessary the selection of appropriate auxiliary orthopedic equipment (canes, crutches, walkers). Possible supplements include occupational therapy and education involving the patients and their families, to make them familiar with the specific nature of the disease, ongoing conservative treatment, prevention, and surgical options.

Unfortunately, conservative treatment of osteoarthritis only slows the progress of the disease, and is therefore associated with the slow deterioration of the patients' overall efficiency and their ability to perform activities of daily living, such as walking, washing, performing physiological functions without assistance, dressing, preparing meals, etc. That is why a person who has severe pain while walking, even when at rest, and significant motor deficits, even with small radiographic changes, requires surgical treatment. The method of choice is the replacement of the overused or damaged joint with an artificial one. In the overwhelming number of cases this concerns older patients (over 65 years of age), especially women (at a ratio of 3:1). Hip prosthesis implantation in these patients has now become standard procedure in Poland and worldwide.

The creator of replacement arthroplasty is considered historically to be Themistocles Gluck, who in 1891 developed and implanted the first artificial ball-and-socket joint. Further studies were focused on finding new materials for the implants, new models and surgical techniques. The most significant development of hip joint replacement began in the 1960s and continues until today. The founder of modern total joint replacement is J. Charnley, who made the first implantation of a hip prosthesis with a polyethylene acetabulum. Since 1951, polymethylmethacrylate has been used as bone cement for fixing cemented prostheses. However, a fundamental feature of this cement is its "aging," as evidenced by the occurrence of cracking and irritation due to reactive granulation tissue, which separates the cement from the bone, leading to loosening of the prosthesis. The development of technology and operating methods did not produce improved rehabilitation until the 1980s. In general, cemented prostheses are used to treat older patients, for whom early mobilization is important with full weight bearing during ambulation with both lower limbs. This is important because of age-related, physiological changes in motor coordination and muscle strength and to prevent complications from the respiratory and circulatory systems.

The first cementless prosthesis was applied in the 1980s. These prostheses are designed for young people with the potential for regeneration and osteogenesis of the bone, and good structural conditions of the acetabulum and femur. The construction of cementless endoprostheses is intended to match the material to the biological and strength features of the bone. The fastening elements of cementless prostheses are the result of many studies, which have recently led to the creation of threaded or press-fitted cups. The construction and method of mounting screwed-in and press-fitted prostheses produces good stabilization and the ability to distribute forces evenly over the entire length of the stem and acetabular surface, which also allows for quick loading of the limb.

The further development of arthroplasty depends primarily on interdisciplinary cooperation with physicians, engineers, and physiotherapists. The introduction of the implant to the bone always changes the distribution of internal stresses. Biomechanical studies (Będziński & Ścigala, 2000) on the effects of various types of endoprosthesis stems on the strain in the shaft of the femur showed non-physiological stress distribution and deformation of bone tissue in the case of long stems. Recently short-stemmed prostheses allow for a more favorable distribution of bone strain and smaller overloads in some areas within the femur

when loading the lower limb. Evaluation of the results of surgical treatment and rehabilitation with the use of short-stem endoprosthesis shows a subjective reduction in pain intensity and less time to stand up and learn to walk, which is beneficial for speeding up the healing process and returning the patient to independent performance of activities of daily life after 4 - 8 weeks. This is also a financial issue (shorter hospital stay, no need for third party assistance, etc.).

Development of the stem design for the hip prosthesis has been moving in the direction of shorter and smaller stems, in which the stress distribution between implant-bone will allow the most accurate reproduction of physiological conditions. New solutions in hip surface replacement are also used for this purpose. In addition, the way of thinking has changed in favor of implanting a greater number of cementless prostheses in the elderly, whenever proper bone structure allows for such a possibility.

The criteria for evaluating treatment outcomes using endoprosthesis are the same for all stypes, and include the assessment of prosthesis stabilization, subjective sensations of pain, and functional capacity, as affected by muscle strength and range of motion. Muscle strength, an important factor for functional capabilities, depends partly on individual and hereditary characteristics, such as the cross section of the muscle and its structure, but primarily on the level of physical activity (Wilk et al., 2004; Wilk & Frańczuk, 2003, 2005a; Wilk-Frańczuk et al., 2011). The latter develops and takes shape during normal human development. Rapid increases in muscle strength begin in boys at age 13-14 and lasts until age 19-20. In later years (after age 30) it remains constant, then decreases. In girls, the stabilization of muscle strength occurs after puberty. As a result of the processes of human aging, physical capacity gradually decreases. Between the ages of 20 and 30 years, skeletal muscles make up about 45% of the human body, but after 70 years of age, only 27%. The decrease in muscle strength (about 1% per year) as a result of the process of aging is caused primarily by progressive muscle atrophy and changes occurring in peripheral nerves. This leads to limitations, and even loss of locomotion, which is a serious problem because it leads to a decrease in the cardio-pulmonary exercise capacity of the patient and the development of metabolic diseases. In the United States, research on the effects of rehabilitation combined with strength training for older people found that even at the age of 90 it is possible to increase isometric force, slow down significantly the loss of muscle mass, and enhance locomotor capabilities.

In the case of hip arthroplasty with a prosthesis, functional outcome seems to be the most convincing parameter of assessment, hence early and appropriate rehabilitation is very important to obtain the best functional outcome, as we have emphasized above. Arthroplasty, by eliminating pain and increasing the range of motion in the joint that is reduced by osteoarthritis, allows training to be intensified, which increases muscle mass and strength. Thus the patient gets, in addition to pain relief, the possibility of recovering locomotion, and thereby obtains greater functional efficiency and an important factor contributing to a higher quality of life (QOL). Patient assessment from this point of view is rare in the literature, where most of the authors work on a variety of point-scales, taking into account the local and overall efficiency of the patient, and in some cases also the radiological picture. For many years the basic, relatively simple method of evaluating the functional status of the patient after surgery arthroplasty was the Charnley or Harris test. This assessment is still widely used as an additional outcome measure. The value of the Harris scale (Harris Hip Score) has been well documented in the literature (the scale has been in use since 1969). It also features very reproducible results, and the evaluation



includes the assessment of QOL parameters. The Harris scale assesses the following groups of parameters: pain (intensity, medications used); gait (limping, use of crutches or canes, walking distance); performance of daily activities (climbing stairs, sitting, tying shoes); ability to use public transport; hip range of motion (detailed ranges); presence or absence of deformities (contractures or shortening of the limb).

The end result of the evaluation of individual parameters is a sub-point value, all of which when added give the total score on a scale from 0 to 100 points.

A number of other scales have been developed for the clinical evaluation of patients with osteoarthritis of the hip, before and after surgery. Currently in use, in addition to the aforementioned Harris scale, are the Merle d'Aubigne-Postel scale, the Bellamy scale, the WOMAC scale (Western Ontario and McMaster Universities Questionnaire), whose particular advantage is allowing the patient to make a self-assessment, the JOA scale (Japanese Orthopaedic Association), the Wolfe scale, and the Lequesne scale.

Technological progress has made it possible to develop more objective methods for assessing the results of arthroplasty. These include the assessment of gait parameters. The basic parameters initially used to evaluate gait basic included gait speed, step frequency, and step length, measured by means of micro switches attached to the patient's shoes. In subsequent years there has been a new method to identify and assess the symmetry of the lower limbs and gait cycle phases using miniature accelerometers. There is also a more thorough analysis of gait using a series of images made with the patient walking, at a frequency from 300 to 1200 shots per minute, or even something as unusual as the method developed by Bergman's team, based on the implantation of a prosthesis fitted with a telemetry transmitter. Another contemporary method is to measure ground reaction forces during gait using dynamographic platforms. These allow us to measure ground reaction forces in all directions and linear momentum, and therefore to assess the accuracy of limb loading when walking. Currently, the latest optical electronic devices have been used to develop gait analysis systems for registering the movement trajectory of markers placed on the patient, often with the addition of integrated graphics platforms, known as dynamographic platforms. There are also other devices, such as, for example, gas meters for measuring oxygen and carbon dioxide in exhaled air, and electromyography.

Such tests allow us to collect a large amount of information; however, they are feasible only in specialized laboratories and report only the overall efficiency of the system. Assessment by these means is incomplete and does not affect measurements of range of motion in the operated joint and the pelvic girdle muscle forces responsible for individual movements. Such studies may be more useful for assessing the efficiency of locomotion, and indirectly serve to evaluate the use of implants, but they do not return function and muscle strength. Recently, encouraging results of functional assessment of muscles and ranges of motion after implantation of prostheses in the operated limb have been obtained using the technique of wireless surface electromyography – sEMG (Maguire et al., 2010).

There is no generally accepted rehabilitation protocol for patients after total hip replacement with cemented or cementless prosthesis. The differences relate to both the methods of rehabilitation and the date of commencement of full loading of the operated joint (Iyengar et al., 2007; Wilk & Frańczuk, 2005a). A constant search for optimal solutions is therefore necessary. Rehabilitation after cemented hip arthroplasty starts from the first day after surgery with the introduction of breathing exercises. The second day begins with isometric exercises, passive-active exercises of the operated limb, active exercises of the unaffected limb and upper limbs. On the third day we begin to stand the patients up and teach them to

walk with crutches or a walker with no weight bearing. What is most preferred, however, is for the patient to behave consistently with the features of normal gait - the operated foot is put on the ground with no weight bearing. At the end of the first week after the operation, gradual loading of the operated limb begins, starting with 20-30% of body weight. A weight training floor is most often used to teach the patient the proper balance of body weight. Full weight bearing is applied after the stitches have been removed.

In the case of cementless hip arthroplasty, all motor activity is often delayed. Exercises usually begin on the first day, but the patient stands for the first time on the 5<sup>th</sup> to 14<sup>th</sup> day after surgery, and partial loading of the operated limb starts 4-6 weeks after surgery, with full weight bearing after 3-4 months. Some authors recommend no weight bearing for up to 6 months, although others support full weight bearing as soon as possible (2-3 days after surgery), especially when screwed-in implants have been used (e.g. Zweymüller-Stemcup). In general, in the first weeks after arthroplasty the appropriate positioning of the operated limb is recommended - slight adduction, 5 degree hip and knee flexion, neutral rotation position. Excessive abduction, internal rotation and crossing the legs are contraindicated.

Based on many years of research and observation, I believe that after the standard procedure, when the prosthesis is properly implanted, the rehabilitation protocol for both cemented and cementless prostheses should be the same, and include early loading of the operated limb (Cichy et al., 2008; Wilk & Frańczuk, 2003, 2004). This does not apply to non-standard patients (extra implants strengthening the acetabulum, bone grafts, proximal femur fracture fixation, etc.). Limb loading in these cases is delayed; the patients usually walk with crutches till the bone is healed, and after that gradual weight bearing is introduced. It is best to start learning before surgery.

It has been shown that in the first period after surgery the greatest impact on the progress of rehabilitation results from: minimally invasive surgery within the interval between the tensor fasciae latae, rectus femoris and sartorius muscles, or within the interval between the tensor fasciae latae and gluteus medius muscles; epidural analgesia in the first 24 hours after surgery; the use of Continuous Passive Motion (CPM) in the first days after surgery.

In contrast to arthroplasty performed with minimally invasive approaches, the other operating approaches require a delay in the entire rehabilitation process, mainly related to standing the patient up and teaching ambulation, even by a few weeks, because premature active rehabilitation in the first weeks after surgery can lead to dislocation of the implant (Dudda et al., 2008). The type of implanted prosthesis may also affect postoperative functionality.

A common problem after total hip replacement is a subjective sense of unequal length of the legs. If there is no actual reduction in the relative limb length, one should take into account the possibility of pelvic positioning dysfunction, which can be expressed by the asymmetry of iliac spine positioning (anterior superior and posterior superior). Asymmetrical muscle tone can be the cause of this.

About 1100 hip and knee replacements per year are done in our center (the Cracow Rehabilitation Center). Lateral or antero-lateral approaches are routinely used for hip replacement, and the anterior approach with ischemia for knee replacement. The mean operating time for this type of treatment varies between 45 and 60 minutes, with spinal anesthesia, and the patients are subjected to a constant process of rehabilitation. Before the operation the patients are informed about the stages of rehabilitation that will follow, and learn to walk on crutches with different loads on the lower limbs, which increases their conscious and active participation in the treatment process.

On the first post-operative day CPM is introduced, which improves the limb blood supply, accelerates the absorption of the hematoma, reduces the hypertonicity of periarticular tissues, and allows the patient to get rid of the anxiety associated with the movement of the operated joint. In subsequent days, exercises are gradually introduced, applying the principles of individualization and gradation of difficulty. On the third day, walking re-education begins, with gradually increasing weight bearing and the use of appropriate orthopedic aids (walker, crutches). Due to the fact that arthroplasty is most often related to a chronic degenerative process, which also causes major progressive pathological changes in connective tissue and contributes to a significant reduction in patient activity, special attention is paid to the restoration of normal movement patterns. It is also essential to learn to maintain and control proper posture, which may be disturbed due to the abnormal movement patterns both before and after surgery (e.g. due to the constant need to relieve one leg, abnormal movement with the use of one crutch).

One of the characteristic features of degenerative joint diseases is that only a relatively small percentage of the patients who present for treatment (8-10%) are vocationally active. Many studies have shown that once patients have been relieved of their pain symptoms, they are more willing to exercise and become physically active. It is also important to draw attention to the analysis of treatment outcomes in the first period after surgery. This period is especially important, since exercises can be intensified immediately after surgery, and it is during this period that CPM can be applied most effectively. In any event, the impact of the latter is not perceptible at a later stage. Early rehabilitation (especially CPM), commenced immediately after surgery, along with appropriate pharmacotherapy and the application of elastic pressure stockings on the lower limbs, also helps to prevent such complications as pneumonia, venous embolisms or thrombosis. This is consistent with the observations of other authors. The results of studies on muscle strength suggest that muscle strength begins to recover about 3 months after surgery, while an appropriate program of rehabilitation can lead to increased muscle strength within 6 months. This observation is confirmed by the analysis of range of motion. When functionality is evaluated according to the Merle D'Aubigne functional scale, published research results indicate that a distinct majority of patients recover good functionality in the operated limb after six months. These results are similar to those obtained in respect to muscle strength, although they do not in fact show the dynamics of change in respect to either muscle strength or range of motion.

In the prevention of disorders of posture, those patients who will have to use elbow crutches for a longer period of time are advised to use two crutches rather than one, which affects the symmetry of body work during ambulation. Approximately one week after surgery, the patient learns to walk up and down stairs, initially leading with the non-operated limb while going up, and with the operated limb while going down. Throughout the period of treatment we adapt the rehabilitation program to the individual patient, and where indicated we use other physiotherapeutic methods (e.g. physical agents).

The rehabilitation applied initially in the orthopedic department should be continued later at home, with the cooperation of the family, or, if that is not possible, in a medical rehabilitation unit (Iyengar et al., 2007). The lack of appropriate rehabilitation in this early period can often seriously undermine the effects of the surgeon's efforts. In the later, post-discharge period, our patients are often advised to try Nordic Walking.



### 3. Rehabilitation after arthroplasty of the knee

From the clinical point of view, as previously stated, gonarthrosis, along with coxarthrosis and spondylarthrosis, is among the most significant joint pathologies. When the changes are significant, gonarthrosis can be handicapping, while pain occurs with even minor deviations from the physiological norm. In most cases the causes of the disease are difficult to determine, since degenerative and deformative changes do not constitute a unified nosological entity, but rather a syndrome of pathological changes caused by the operation of various etiological factors. Research has shown that gonarthrosis does not affect only the elderly, since degenerative changes in the knee also occur in much younger persons. Among the generally recognized risk factors are the following: abnormalities in joint structure; biomechanical disturbances; overloading of the joint; microlesions; obesity.

Gonarthrosis can also be caused by deformities (varus more often than valgus), which cause one of the joint components to be overloaded. Conservative treatment consists in rehabilitation and pharmacotherapy, while patients are advised to adopt a conservative lifestyle and lose weight. The degenerative process that has begun is slowed down under the influence of conservative treatment, but even so the changes tend to progress. As in the case of hip arthroplasty, the appearance of severe pain that occurs both during ambulation and at rest, along with restricted range of motion in the knees, eventually leads to a significant degree of disability. In that situation, the treatment of choice is surgery, involving the replacement of the damaged joint with an artificial one.

The physiological exhaustion of tissue that is characteristic of aging, especially in the weight-bearing joints, is one of the most commonly cited causes of primary degenerative disease of the largest joint in the human body, the knee. The external loads on this joint that result from the forces of gravity and ground reaction are to a large extent dependent on body mass. The load on the joint in standing position constitutes approximately 43% of body weight (Kabsch & Bober, 2001). During ambulation, the pressure on the joint surfaces changes depending on the gait phase: the greatest load occurs at the beginning of the support phase. These parameters can also change in the event of varus or valgus deformations of the joint, which amplify the pressure on the most heavily loaded parts of the joint. Biomechanical research has produced different models of knee joint loading (the Maquet model, the Denham model), taking account of asymmetrical loads on joint surfaces in the case of varus or valgus deformities of the lower joints. Indeed, such deformities are among the indications for surgical treatment. When the angle of deviation is not too great, correctional popliteal osteotomy of the tibia is applied. Deformities that produce a greater angle of deviation require arthroplasty with endoprosthesis, especially when they are accompanied by deformities of the joint surfaces.

As in the case of the hip joint, the increased number of knee arthroplasties performed in the last decade has produced a search for new solutions in surgery and rehabilitation. The first knee endoprostheses were implanted in the 1950s, when a leading role in their development was played by Smith-Petersen, Waldius, and Campbell, among others. These prostheses had a hinge construction, which often caused early loosening. In the 1960s and 70s, new types of prosthesis were introduced. In 1971, the Canadian surgeon Frank H. Gunston, who was cooperating at that time with Sir John Charnley on a new type of hip prosthesis (consisting of a metal femoral part mounted on bone cement and a polyethylene acetabulum), developed a polycentric knee prosthesis, based on their joint research. Since that time there has been constant progress, thanks to research on improving the construction of the

prosthesis in such a way as to reproduce most accurately the movement of a natural joint, and on the application of construction materials that are as biocompatible as possible. Many prosthesis models have been designed, two of which are currently most often used: mobile-bearing and fixed-bearing, posterior stabilized with a pin to replace the functions of the posterior cruciate ligament. Among these designs there are many types of prostheses that can be adapted to the individual patient, including, for example, unicompartmental prostheses (Zeni & Snyder-Mackler, 2010).

Both types of prosthesis, mobile-bearing and fixed-bearing, have their adherents. In the case of mobile-bearing prostheses, what is emphasized is the possibility to achieve a greater range of flexion in the knee joint and a physiological gait. Fixed-bearing prostheses, in turn, provide greater possibilities to correct deformities in the knee joint, but they can also cause shearing forces to develop, which can lead to loosening of the joint. However, it is often emphasized in the literature that the frequency of occurrence of loosening in both types of prosthesis is comparable. On the other hand, in the case of the knee joint, the implantation of a prosthesis with a modeling system that uses an MRI of the lower limb reduces bleeding (since it is then unnecessary to open the medullary canal), shortens operating time, and, as indicated by preliminary studies, makes it possible to obtain better outcomes, in terms of a quicker recovery of full functionality of the operated limb.

Progress and the development of knee arthroplasty with endoprosthesis has made it necessary to adapt rehabilitation procedures, so as to obtain the best possible outcome for the patient. There are many different factors, before, during, and after surgery, that can affect the treatment outcome; the primary goal of the surgery itself is to reduce pain and increase the range of motion in the limb affected by pathological changes. These two effects, in turn, are intended to promote recovery of normal gait, thereby allowing the patient to regain functional independence and normal activity in daily life, which is a major factor in QOL. It should be obvious, then, that proper rehabilitation, adapted to the individual needs and capabilities of the patient and to contemporary standards of practice, plays a very significant role in outcome. In publications from as late as the mid-1990s, there are still descriptions of post-operative rehabilitation that began on the 2<sup>nd</sup> or 3<sup>rd</sup> day after surgery with kinesitherapy (active-passive and passive exercises), becoming gradually more intensive over the next several days. It was only on the 8<sup>th</sup> day after surgery that the patient was encouraged to sit on the edge of the bed, and on the 10<sup>th</sup> day that the first attempt was made to stand the patient up, followed by ambulation training from the 12<sup>th</sup> to the 14<sup>th</sup> day (Nolewajek et al., 2008), who studied the risk factors for deep vein thrombosis in the lower limbs in patients after total knee arthroplasty, found that the time when the patient first stands up is of major importance in the prevention of embolic or thrombotic complications, alongside age, obesity, and duration of surgery. Rehabilitation after arthroplasty of the knee is oriented primarily towards allowing the patient to return to normal activities of daily living and functional independence as soon as possible.

An appropriate program of rehabilitation is thus an essential element in treatment, to prepare the patient for surgery and after surgery, with the goal of standing the patient up as soon as possible, teaching ambulation, and recovering as much functionality as possible. The rehabilitation process is often lengthy, and the patient's physical fitness before surgery is of no small importance. Currently, given the necessity to adapt the rehabilitation program to each individual patient, rehabilitation begins on the 1<sup>st</sup> or 2<sup>nd</sup> day post-operatively, with respiratory exercises and isometrics, accompanied by active-passive and active exercises.

The patient stands for the first time on the 2<sup>nd</sup> or 3<sup>rd</sup> day post-operatively, initially with a high walking platform, followed by ambulation training with elbow crutches. On the 7<sup>th</sup> to 9<sup>th</sup> day post-operatively the patient begins to learn how to walk up and down stairs, and then, depending on the patient's fitness and gait mechanics with crutches, two-beat ambulation with a single elbow crutch on the arm contralateral to the operated knee. It is essential, however, to pay attention to the patient's body posture in motion, and if asymmetrical shoulder positioning is observed during ambulation with one crutch, then the use of two crutches is recommended. Just as in the case of hip replacement surgery, this prevents the patient from becoming accustomed to an abnormal pattern of motion.

The rehabilitation of patients after total knee arthroplasty is a complex task for the physiotherapist. An important goal is to achieve full extension of the joint and the greatest possible flexion. This task is rendered all the more difficult by the fact that practically every patient has pain symptoms that hinder or prevent intensive kinesitherapy. Pain reduction, then, can be regarded as the first goal of rehabilitation. An analysis of the impact of low temperatures on the human body leads to the conclusion that its analgesic effect is the one felt most quickly. In the research group, this effect was noted in all patients. The analgesic effect has been observed by many authors, in respect to different joints (knee, hip). The research performed first by our group on the application of local cryotherapy in the treatment of painful shoulder syndrome has shown that this method makes a major contribution to eliminating pain, which makes it possible to implement therapeutic exercises at an early stage. Under the influence of pain, a vicious circle often forms: pain causes a limited range of mobility in the joint, which leads to increased muscle tension and further limitation of motion, steadily increasing the level of pain.

The implementation of a systematic rehabilitation program for patients after total knee arthroplasty, both cemented and cementless, not only produces good outcomes, but also, as in the case of other surgical procedures, prevents complications. Among the rehabilitation techniques used with knee arthroplasty patients there are some special methods, such as CPM, biological feedback devices, or physiotherapy, especially local cryotherapy (Wilk & Frańczuk, 2004, 2005a, 2005b). Disturbances of proprioception after surgery render it necessary to include exercises in a closed kinematic chain and exercises to correct equilibrium in the later stage of the rehabilitation program.

Stabilometric platforms or parapodiums are very useful for evaluating equilibrium in patients recovering from total knee arthroplasty. These devices, in addition to teaching various activities, often connected with biofeedback, can also provide an objective evaluation of treatment outcome. The application of rotors with computer analysis of training supports the proper training of the symmetrical work of the lower limbs after total knee arthroplasty.

#### **4. Rehabilitation after arthroplasty of the hip or knee in older patients**

The increasing percentage of older persons in the general population is making it essential to search diligently for ways to preserve a level of fitness that would allow functional independence to be preserved, even in advanced old age (Marks, 2010). At present the maximum duration of human life is estimated at 110-120 years (though there are persons who live longer, and there are frequent news reports about persons who are older yet), but this pertains to persons characterized by exceptional genetic traits, and is also conditioned by biological and environmental conditions. An example of this problem might be the more

than 100,000 centenarians living in Japan, as compared to some African countries, where the average life expectancy does not exceed 50 years. Still, given the increasing life expectancy, the literature increasingly divides the older population into three separate age brackets: the “young-old” (65-74), the “old old” (75-84), and the “oldest old” (over 85) (Evgeniadis et al., 2008; Wilk-Frańczuk et al., 2011; Wright et al., 2011). This increasing life span, undoubtedly related to the progress of civilization, including advances in medicine, means that more and more people are reaching the age of 65 in much better health than was the case in previous generations. Women continue to make up a majority of the older population, since their life expectancy is several years longer on the average than that of men. However, research performed with a group of 94 centenarians showed that the men in this group, though they made up only 12% of the whole group, were in better physical condition and generally led a more active life.

In spite of the fact that a constantly growing number of older persons are fitter and more active than before, still, the progress of involutionary processes in physiological aging causes limitations and poses numerous problems, especially after age 75. The frequent co-occurrence of several pathological processes with the physiological changes of normal aging often makes diagnosis and treatment difficult. The problems are compounded by deteriorating sensory perception and frequent depressive episodes, which renders it necessary to make medical personnel aware of the differences in the course of disease and associated treatment in the elderly patient.

One of the basic goals of treatment is to make it possible for the older person to return to independence in activities of daily living. This is conditional upon good health, and fundamentally affects the quality of life. The period during which the patient is dependent upon someone else should be as short as possible, and the family's support should be oriented towards motivating the patient to return to health. The primary means to achieving the greatest possible functionality and maintaining it throughout the lifespan is comprehensive rehabilitation, understood both as the sum of all its components, and as a model of procedure. The individualization of this process is particularly essential in older patients, especially in respect to the possibility of conducting parts of the rehabilitation program in the patient's home or in the form of ambulatory rehabilitation. This reduces the appearance of cognitive and emotional disturbances associated with the stress that is caused by being away from home, in an unfamiliar place. Older patients are often reluctant to agree to hospitalization, since for them the hospital is associated with serious illness and death. In situations where a hospital stay is inevitable, for example when surgery is necessary, its duration should be as brief as possible.

Currently, modern rehabilitation is creating conditions for standing the patients up and teaching them to walk as early as possible. In older persons with deformative and degenerative changes, eliminating pain and increasing locomotor capacity, in terms of gait ergonomics and efficiency, is of crucial importance to quality of life. One of the factors that has the most influence on the whole course of rehabilitation is the possibility of full weight bearing on the operated limb at the earliest possible moment. Another factor that reduces the number of potential fatal post-operative complications has been the introduction, since the beginning of this century, of preventive measures against thrombotic and embolic complications, not only in the form of low molecular weight heparin, but also thanks to changes in the philosophy of rehabilitation and a more active approach to elderly patients. This pertains not only to patients in orthopedic and traumatological wards, but also others, for example, patients in cardiological units after a heart attack. A more active and earlier



rehabilitation based on early standing and the application of modern physiotherapeutic methods, such as CPM and other forms of kinesitherapy, has become something like a natural supplement to surgery. Of particular significance in this group of patients are the following: comprehensive, interdisciplinary preparation for surgery; rehabilitation that begins even before the operation; weight-bearing on the operated limb as soon as possible after surgery (Wilk & Frańczuk, 2004).

All of these factors contribute significantly to enabling the older patient to recover functionality, reducing the period of dependence on others, and improving the quality of life. The individualization of treatment, in turn, involves taking into account all dysfunctions and the level of mental and physical fitness, as well as the patient's involvement in planning rehabilitation. Currently, due to changes in both orthopedic procedures and rehabilitation, the mortality rate in this patient group is not high (several percent), and is more dependent on concomitant disorders in elderly patients, such as diabetes and other diseases, or dementia, which can hinder cooperation with medical personnel, or the medical history, than on the arthroplasty itself. This is also indicated by the results in hip arthroplasty that are now being achieved even in patients over 85, the "oldest old". The final outcome of rehabilitation in these patients has not been observed to be significantly different from those of patients in other age brackets.

The rehabilitation program is always adapted to the current condition and subjective well-being of the patients, as well as their individual physical capacities. Before arthroplasty there are active, assisted, isometric, and respiratory exercises, along with positions and exercises to prevent edema. The patients are informed about what will happen after surgery, how soon they will stand and learn to walk, and about increasing weight-bearing on the operated lower limb with a walker and elbow crutches. All patients receive pharmacotherapy to prevent thrombosis for 14 days after surgery, while still hospitalized, using low molecular weight heparin administered subcutaneously (which is also continued after discharge, for an average of about 6 weeks). Elastic stockings are used in the perioperative period, and epidural anesthetics are also administered for a period of 48 hours after surgery. Rehabilitation commences on the first day after surgery, using respiratory exercises, which are continued as long as the patient remains on the ward. Next, on the second and third days, there are isometric and active-passive exercises for the operated limb, as well as CPM using electrical rail devices, such as the Artromot, Physiotek, or Canwell machines (extension and flexion of the hip with simultaneous flexion of the knee, and with the last-mentioned device, the ankle joint as well). The range of flexion in the hip joint is gradually increased to the extent possible given the patient's capacity. During this same period the patient gradually begins to stand, beginning with sitting on the edge of the bed, then standing beside the bed with a walker and learning to walk. As muscle function is recovered in the lower limb, the program is expanded to include assisted and active exercises, the walking distance is increased, and more weight is placed on the operated limb. On the 11<sup>th</sup> or 12<sup>th</sup> day after surgery, the first attempts are made to walk up and down stairs. There are two rehabilitation sessions daily (with CPM for 120-180 minutes a day), and after discharge the patient is instructed as to how to proceed further.

An important new direction for research in this area is the evaluation of posture stability, equilibrium, and displacing the center of gravity. For this purpose it is possible to use both clinical tests and appropriate devices, which often allow for a graphic display of the results. One example of this type of apparatus is the static-dynamic parapodium, to which a special computer program can be added, both to make a graphic representation of the results of



rehabilitation and to provide exercises for the patient. Such devices can also be used to evaluate the risk of falls in those cases where the risk is greatest, i.e. with elderly patients. Thus the results of these tests can also have an indirect effect on the prevention of fractures (Wilk & Frańczuk, 2003; Wilk-Frańczuk et al., 2010).

As previously mentioned, the dysfunctional changes that occur with older patients co-occur with the physiological processes of aging. We are often dealing with the simultaneous appearance of different diseases associated with this period of life and those that occur in other age groups as well, which in the elderly may or may not show characteristic features. This co-occurrence of pathological changes often leads to handicap, which is especially true of disorders of the musculo-skeletal system, such as degenerative changes, rheumatoid arthritis, or osteoporotic fractures, as well as disorders of perception (Piva et al., 2011). That is why rehabilitation begins before the planned surgery, which makes it possible to prepare the patient and minimize anxiety about life after the surgery, through conscious planning of activities and the repetition of previously learned and already familiar patterns of motion. The changes occurring in old age, along with pathological changes that impair perception and the posture control system, lead to disregulation of stability, and often, as a result, to falls, which are the major internal cause of injuries and fractures in older persons (the external causes include environmental and situational factors). In as many as half of these patients, repeat injuries occur.

This problem also affects persons who have undergone arthroplasty, for whom the consequences of an injury are particularly dangerous due to their impact on the implant. Various parameters are used in tests involving the evaluation of equilibrium and stability in older persons, including especially the Tinetti test, the Duncan test, the Berg scale, or the Romberg maneuver. Nevertheless, for purposes of prevention in elderly patients it is essential to use methods and exercises aimed at improving equilibrium. The rehabilitation program should also include exercises to increase muscle strength in the upper limbs, especially the shoulders. This is very important for the patient's locomotion during the early post-operative period, when the patient is forced to move about on crutches. As in other age groups, walking on crutches should be symmetrical, preferably two-beat with symmetrical work of the upper limbs. Family support is also particularly important, oriented towards motivating the patient to take an active role in the process of treatment and supporting the patient's desire to recover fitness and health, and to continue rehabilitation later, at home (Iyengar et al., 2007).

## **5. Reeducation and methods of evaluating and testing gait**

Walking is the most important means of human locomotion, and the inability to walk has a significant negative impact on QOL (Starowicz et al., 2005). Walking can be defined as a rhythmic, alternating movement of the lower limbs, combined with displacement of the trunk and concomitant movements of the upper limbs. During normal gait one lower limb is always in contact with the ground through the foot; what differentiates walking from running, then, is that in the former there is a phase of double support, which in running is replaced by a phase of flight.

Walking requires the simultaneous participation of all the joints in the lower limb in an extraordinarily complex movement chain. In addition, movements in the spinal joints, including the cervical segment, are of great importance, as are the alternating movements of the upper limbs. The involvement of all parts of the body in the mechanism of walking

requires a well-coordinated, complicated control mechanism in the nervous system, which explains why walking is not possible immediately after birth, when the nervous system is not yet fully developed. Normal, physiological walking as a means of locomotion is extraordinarily energy efficient, which is why even slight disturbances increase the energy cost and reduce effectiveness. There are two phases in walking on a level surface when the energy cost is high. The first of these is when walking begins, when it is necessary to overcome inertia in order to displace body mass forward, and the second is stopping, when it is necessary to inhibit the movement of the limbs and trunk.

The kinematic pattern of normal gait is very similar in everyone. This is especially true of the movements that take place in all the joints involved in walking in the sagittal plane (e.g. in some people we can see greater deviations of the center of gravity while walking). The forces at work while walking result from the actions of muscles that evoke acceleration and slowing of the appropriate parts of the body, along with gravity and momentum. Walking is often described as an alternating process of losing and regaining equilibrium. Taking a step is associated with throwing the foot forward and displacing the body's center of gravity forward, which produces a loss of equilibrium. The forces of gravity and forward momentum cause a resultant continuation of the movement that has just begun. The fall is avoided by the reflex strategy of regaining equilibrium, i.e. the reaction of putting the foot on the floor, which is associated with the return of the center of gravity into the projection area of the rectangle of support. If walking is to be continued, the center of gravity must once again be displaced forward. During the next step, propulsion results from a much weaker contraction of the flexors in the calf of the leg, thanks to the momentum gained in the preceding step; then the body moves forward, and the next reflex step occurs. This mechanism is continued for as long as desired, and the momentum achieved allows for energy conservation as soon as an even cadence of successive steps is achieved.

The movement pattern in the hip joint is much less complex during walking than in the knee or ankle joints. In the entire walk cycle, the hip joint has one extension phase and one flexion stage, whereas the knee and ankle joints each perform two phases of each type in one cycle. However, while in the knee and ankle joints the range of motion involves only the sagittal plane (flexion and extension), the proper participation of the hip joint in walking requires a free range of motion in all three planes, since abduction, adduction, and rotation are elements of gait markers, i.e. factors contributing to the reduction of displacing the center of gravity. The limitation of abduction, adduction, and rotation results in the disruption of this mechanism, which is why the range of flexion and extension in the hip joint can often be preserved even when walking is impaired. When the heel strikes the ground, the hip joint is in light flexion, while the gluteus maximus and the posterior thigh muscles immediately contract, in order to initiate extension of the hip joint. The knee joint is in full extension or about 5° of flexion, while the posterior group of thigh muscles control the flexion of the knee that follows after the heel hits the ground. The upper ankle joint is in almost full dorsal flexion. When the body mass is shifted onto that limb, the group of hip adductors begins to act, followed almost immediately by the hip abductors, stabilizing the pelvis relative to the thigh. At the same time, the gluteus maximus tenses, extending the hip and stopping the internal rotation of the thigh. During the support phase, extension begins in the hip joint, as a result of the action of the extensor muscles; the knee joint increases its flexion in order to minimize the impact of the heel striking the ground and the vertical displacement of the center of gravity, which occurs when the weight of the body is displaced forward above the limb stabilized on the ground.

The flexion of the knee in the support phase is one of the classic gait markers, and can assume a value up to  $30^\circ$ . In the ankle joint, there is a controlled plantar flexion for safe release of the foot onto the ground. The contraction of the quadriceps softens the impact of the heel on the ground and controls the momentum of the body, now pushing the knee forward. In the support phase, the activity of the muscles virtually stops, with the exception of the calf muscles. This group begins to act during this phase, achieving its greatest activity just before the heel is lifted from the ground. The phase of taking the heel off the ground follows, as a result of propulsion and displacement of the center of gravity to the anterior part of the foot after full dorsal flexion of the foot has been obtained. Towards the end of this phase the contraction of the flexors of the foot adds the movement component necessary to push off from the ground. Then the hip adductors begin again, and the cycle starts all over.

The rehabilitation of arthroplasty patients should always be connected with reeducation in walking, preceded by a thorough evaluation of its mechanisms and existing disturbances of motion in the joints, and the activity of the particular muscles. The high degree of complication of the act of walking requires that it be divided into components for the sake of analysis. Some of the terminology pertains to the duration of particular phenomena, some to the spatial positions, the values of forces, and the distances covered by particular parts of the body (e.g. length of stride, length of the walk cycle, the walk cycle, its phases, speed, cadence, and gait markers). Gait disturbances can be viewed in both temporal and spatial relations, which is why a complete analysis must include both of these aspects. A complete gait analysis consists of the following: testing the force of pressure on the ground; a three-dimensional video record of the movement of the patient's anthropometric points; electromyographic tests of the activity of the muscles that participate in walking (Cichy & Wilk, 2006; Cichy et al., 2008; Giaquinto et al., 2007).

The application of all three of these elements gives the most complete picture of gait disturbances. Degenerative disease of both the hip joint and the knee joint significantly impairs the efficiency of gait, leading to a progressive deterioration of the quality of life.

Several specific groups of gait disorders can be noted in patients with osteoarthritis. These result from the major symptoms of osteoarthritis. The most striking change is slow gait, involving the ineffective use of momentum and greater fluctuations in the center of gravity in the sagittal plane. Pain in one of the lower limbs and reduced range of motion in the hip joint, in turn, result in gait impairment in the isometric aspect. So-called unisometric gait is present, and is characterized by impaired coordination, reduced duration of the support phase, shortening of stride length, shortening of the length of the affected limb and longer duration of the gait cycle. The most severe variant occurs when one of the lower limbs (mostly the affected one) is dragged forward, and only the healthy one is pushed forward. In pathological gait associated with osteoarthritis, deterioration of the isochronous aspect is also observed, which leads to the formation of the so-called antalgic gait. The patient then prolongs the healthy limb support phase, in order to prepare the affected limb for contact with the ground, then "jumps" over the diseased limb and tries to put the healthy limb back on the ground. The impaired coordination of upper limb movements is associated with impaired balance and an asymmetrical loading pattern in both lower limbs.

The gait disturbances described above usually present simultaneously. Asymmetry of gait in patients with osteoarthritis of the hip has been noted (Cichy & Wilk, 2006). The asymmetry of the load on the lower limbs in a static test (while standing) is not detectable in

patients, if shortening of the affected limb is not above 2 centimeters. When stride length is observed, changes have been detected in patients with osteoarthritis of the hip compared to a similar age group of the healthy population.

Gait re-education follows the principle of gradation of difficulty, and the program should also include improvement of balance and stability, so it is important to ensure patient safety (prevention of falls). Various methods are used to work with the patient, such as PNF, sensorimotor training, and hydrokinesitherapy. The rehabilitation program usually begins with exercises designed to achieve the correct loading of the lower limbs and gait pattern. Gradation is usually obtained by increasing the time of exercises, the number of repetitions, the distance, or by changing environmental conditions, such as walking on uneven ground, or walking outside the building. It is also important to introduce to the therapy elements of ordinary life, such as moving objects, and so called double tasks, which are intended to distract the patient who is focused on walking (simultaneous conversation, counting, observation, etc.).

## **6. Some special methods used in rehabilitation after total joint replacement**

### **6.1 Continuous passive motion**

Continuous Passive Motion (CPM) is one of many methods of rehabilitation after total joint replacement, which is the modern continuation of the G.J. Zander method, formerly known as mechanotherapy or the Zander method. One of the proponents and supporters of mechanotherapy is R.B. Salter, professor of orthopedic surgery in Toronto, who developed a method of continuous passive motion based on mechanical devices. From 1970 to 1986, Salter conducted research on the negative influence of immobilization on the joints, proving the beneficial effect of intermittent motion, and then continuous motion. In 1978 he constructed the first mechanical CPM device for patients after surgery in the extremities (fractures, arthroplasties). They were used immediately after surgery for a week. Some of the observed benefits include milder and fewer postoperative complications, improved blood supply to the extremities, faster wound healing, and the positive attitude of patients towards new therapies, which is also important. Studies conducted by American physicians from 1981 to 1984 confirmed these earlier observations, and also proved that the time of hospitalization of patients with CPM therapy was shorter compared to the control group, which used traditional rehabilitation. A number of devices have been constructed for CPM, including American devices, called Auto-Flex, the Toronto Medical Corporation's CPM, the German Artromot, and the Chinese or Italian Physiotek or Canwell. They allow the performance of physiological motions in the joints in a certain direction (depending on the device) and predetermined range of motion. At the same time it is possible to adjust the size of the leverage individually to the patient's posture, so that movements are performed in accordance with the joint axes. The authors of studies of the impact of CPM on the musculo-skeletal system draw attention to improved metabolism within the exercised joints, accelerated wound healing, decreasing periarticular soft tissue tension, more rapid absorption of the intra-articular hematoma, better blood supply to the limb, increased strength in the ligaments, and the antiedema and antithrombotic effects and lack of pain during exercise, thus hastening patient recovery (O'Driscoll & Giori, 2000).



## 6.2 Devices with biofeedback

One of the methods currently used in rehabilitation after total hip and knee replacement is the use of devices with biological feedback (biofeedback). These include visual feedback (in the form of images, charts, colors), auditory (sounds of changing intensity), thermal and strength biofeedback. The patient, thanks to the information obtained about how to perform a specific task (depending on the device used) can constantly and actively alter the force required for its implementation, or the method, or the direction, for example, so as to achieve the desired level of accuracy. Treatment with biofeedback is especially helpful in patients with locomotor pathology, which results in disorders in the control of movements, the formation of abnormal movement patterns or problems with balance. Among pathological process of this type, degenerative arthritis of the lower limbs and its surgical treatment can undoubtedly be included, since these disorders lead to disturbances in the normal gait model. Gradual progressive restriction of motion and increasing pain often cause severe impairment of both the mechanics and efficiency of gait. It is not uncommon for patients who have had degenerative arthritis for many years to move with crutches or a cane, and their gait causes pain and becomes increasingly more tiring. Arthroplasty and the postoperative period are also associated with different types of gait disorders, which may also lead to a shift in the center of gravity, which in turn causes an overload of other structures of the musculoskeletal system. Incorrect motor habits often become fixed. It is important, then, after arthroplasty, either hip or knee, for the rehabilitation program to include gait re-education, which can be supported by exercises using biofeedback to restore normal movement patterns (Kuczma et al., 2007; Rasch et al., 2010; Wilk-Frańczuk et al., 2010).

Many types of devices using biological feedback are currently available. Among these are static-dynamic parapodia, which, through dedicated computer software, use mostly video and audio feedback. This allows for balance exercises involving, for example, appropriate balancing and moving the center of gravity, with a visual record of the results. Through these exercises the patient learns to consciously control a particular function in a manner adequate to received visual and auditory information. Parapodia are also used to achieve a passive standing position from sitting in a wheelchair or a chair, while enabling the patient to control the speed of standing up. Another type of device is a gyro, some of which are controlled by computer-aided motion with the possibility of using an electric motor drive. They allow for exercises against active or passive resistance, with a capacity for resistance grading. Visual feedback of speed and asymmetry of the lower limbs are used for this purpose. These rotors are used, among other things, for gait re-education, in order to mitigate the consequences of limitations of physical activity in people with weak muscle strength and spasms. After each exercise the computer built into the device displays an analysis of the training just completed.

Studies on the suitability of equipment using biofeedback show that they allow for the confirmation of function improvement, control of distribution of weight, and stronger patient motivation to take on new tasks related to functional improvement.

## 6.3 Cryotherapy

Cryotherapy, or surface application of cryogenic temperatures to trigger the body's physiological response to cold, can be applied in various forms. It is primarily local cryotherapy that is used, by means of a device that employs liquid nitrogen, carbon dioxide or chilled air. Another form of cryotherapy, general cryotherapy, involves subjecting the



patient's whole body to the effects of low temperatures ( $-110^{\circ}\text{C}$  -  $-160^{\circ}\text{C}$ ) in a cryochamber. In the case of local cryotherapy, the lowest temperatures (measured at the outlet of the nozzle) are obtained by using liquid nitrogen.

Cryotherapy is used in many diseases, including ankylosing spondylitis, rheumatoid arthritis (RA), degenerative joint disease, overstrain and traumatic diseases of the musculoskeletal system, or in persistent pain syndromes. Many authors have shown a positive effect on pain reduction, an anti-inflammatory effect, an antiedema effect, and reduced muscle tension. Low temperatures, thanks to the body's physiological reactions, also make it possible to intensify kinesitherapy. In most patients, the use of topical cooling at very low temperatures results in subjectively pleasurable sensations. This is mainly due to the abolition of pain, enabling intensive exercise, which leads in turn to improved joint mobility sufficient to perform basic activities free of pain. Local cryotherapy treatment implemented in the rehabilitation protocol reduces pain in all patients after total knee replacement, reduces or eliminates edema of the operated lower extremity, and by its analgesic and antiedema effect improves gait efficiency and esthetics. Cryotherapy treatment in the vicinity of the knee allows the cooling of this area of the body by about  $10^{\circ}\text{C}$ , followed by the application of kinesitherapy to speed up warming of the tissues, so that after about 15 minutes the temperature approaches the baseline temperature. Patients with no kinesitherapy after local cryotherapy around the knee note slower warming of the same area (Wilk et al., 2008). The observed effect of faster return of temperature to the baseline value may be due to the so-called after-effect phenomenon, consisting in the fact that intra-articular temperature is close to skin temperature and, unlike the muscles, under the influence of the cessation of cooling is not further reduced. Thus cryotherapy treatments performed on joints require direct kinesitherapy afterwards in order to make proper use the effect of cryotherapy, as was confirmed in the study (Wilk & Frańczuk, 2005b; Wilk et al., 2008).

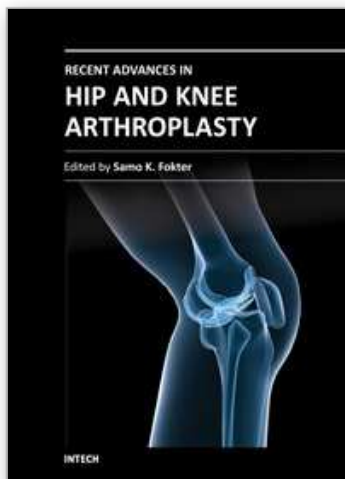
## 7. References

- Będziński, R. & Ścigala, K. (2000). Biomechanika stawu biodrowego i kolanowego. In: Biocybernetyka i Inżynieria Biomedyczna 2000. Tom 5. Nałęcz M. (Ed.), pp.113-158. EXIT ISSN 83-87674-67-2, Warszawa, Poland
- Burnfield, J.M., Shu, Y., Buster, T. & Taylor, A. (2010). Similarity of Joint Kinematics and Muscle Demands Between Elliptical Training and Walking: Implication for Practice. *Physical Therapy*, Vol.90, No. 2, pp. 289-305, p-ISSN 0031-9023, e-ISSN 1538-6724
- Cichy, B. & Wilk, M. (2006) Gait analysis in osteoarthritis of the hip. *Medical Science Monitor*, Vol. 12, No. 12, pp. 507-513. p-ISSN 1234-1010, e-ISSN 1634-3750
- Cichy, B., Wilk, M. & Śliwiński, Z. (2008). Changes in gait parameters in total hip arthroplasty patients before and after surgery. *Medical Science Monitor*, Vol. 14, No. 3, pp. 159-169, p-ISSN 1234-1010, e-ISSN 1634-3750
- Dudda, M., Gueleryuez, A., Gautier, E., Busato, A. & Roeder, C. (2010). Risk factors for early dislocation after total hip arthroplasty: a matched case-control study. *Journal of Orthopaedic Surgery*, Vol. 18, No. 2, pp. 179-183, ISSN 1022-5536
- Evgeniadis, G., Beneka, A., Malliou, P., Mavromoustakos, S. & Godolias, G. (2008). Effects of pre- or postoperative therapeutic exercise on the quality of life, before and after total knee arthroplasty for osteoarthritis. *Journal of Back and Musculoskeletal Rehabilitation*, No. 21, pp. 161-169, ISSN 1053-8127

- Giaquinto, S., Ciotola, E., Margutti, F. & Valentini, F. (2007). Gait during hydrokinesitherapy following total hip arthroplasty. *Disability and Rehabilitation*, Vol. 29, No. 9, pp. 743 – 749, ISSN 0963-8288
- Grotle, M., Garratt, A.M., Klokkeud, M., Løchting, I., Uhlig, T. & Hagen, T.B. (2010). What's in Team Rehabilitation Care After Arthroplasty for Osteoarthritis? Results From a Multicenter, Longitudinal Study Assessing Structure, Process, and Outcome. *Physical Therapy*, Vol. 90, No. 1, pp. 121-131, p-ISSN 0031-9023, e-ISSN 1538-6724
- Iyengar, K.P., Nadkarni, J.B., Ivanovic, N. & Mahale, A. (2007). Targeted early rehabilitation at home after total hip and knee joint replacement: Does it work?. *Disability and Rehabilitation*, Vol. 29, No. 6, pp. 495-502, ISSN 0963-8288
- Kabsch, A. & Bober, T. (2001). Selected issues in the biomechanics of the knee joint. *Polish Journal of Physiotherapy*, Vol. 1, No. 2, pp. 179-182, ISSN 1642-0136
- Kuczma, W., Srokowska, A., Owczarzak, M., Hoffman, J., Hagner, W. & Srokowski, G. (2007). The Phenomenon of Biofeedback in Neurological Rehabilitation Trained on "Balance Trainer". *Acta Balneologica*, Vol. 49, No. 2, pp. 79-85, ISSN 0005-4202
- Maguire, C., Sieben, J.M., Frank, M., & Romkes, J. (2010). Hip abductor control in walking following stroke – the immediate effect of canes, taping and TheraTogs on gait. *Clinical Rehabilitation*, No. 24, pp. 37-45, p-ISSN 0269-2155, e-ISSN 1477-0873
- Marks, R. (2010). Disabling hip osteoarthritis: gender, body mass, health and functional status correlates. *Health*, Vol. 7, No. 2, pp. 696-704, ISSN 1949-4998
- Moody, J. (2000). Recommendations for the medical management of osteoarthritis of the hip and knee . 2000 Update American College of Rheumatology Subcommittee on Osteoarthritis Guidelines. *Arthritis & Rheumatism*, No. 43, pp. 1905-1915, ISSN 0004-3591
- Nolewajka, M., Gaździk, Sz. & Wieczorek, P. (2008). DVT risk factors after Total hip or knee replacement. *Journal of Orthopaedics Trauma Surgery and Related Research*, Vol. 3, No. 11, pp. 17-30, ISSN 1897-2276
- O'Driscoll, S.W. & Giori, N.J. (2000). Continuous passive motion (CPM): Theory and principles of clinical application. *Journal Res. & Dev*, Vol. 37, No. 2, pp. 179-188.
- Piva, S.R., Teixeira, P.E.P., Almeida, G.J.M., Gil, A.B., DiGioia, III A.M., Levison, T.J. & Fitzgerald G.K. (2011). Contribution of Hip Abductor Strength to Physical Function in Patients With Total Knee Arthroplasty. *Physical Therapy*, Vol. 91, No.2, pp. 225-233. p-ISSN 0031-9023, e-ISSN 1538-6724
- Rasch, A., Dalén, N. & Berg, H.E. (2010). Muscle strength, gait, and balance in 20 patients with hip osteoarthritis followed for 2 years after THA. *Acta Orthopaedica*, Vol. 81, No. 2, pp. 183-188, ISSN 1745-3674
- Starowicz, A., Szwarczyk, W., Wilk, M. & Frańczuk, B. (2005). The evaluation of quality of life among patients after total hip replacement. *Polish Journal of Physiotherapy*, Vol. 5, No. 3, pp. 313-322, ISSN 1642-0136
- Wilk, M. & Frańczuk, B. (2003). Analysis of changes in the strenght of muscles acting on the hip joint in patients recovering from hip arthroplasty. *Polish Journal of Physiotherapy*, Vol. 3, No. 4, pp. 309-315, ISSN 1642-0136
- Wilk, M. & Frańczuk, B. (2004). Evaluating changes in the range of movement in the hip joint in patients with degenerative changes, before and after total hip replacement. *Ortopedia Traumatologia Rehabilitacja*, Vol. 6, No. 3, pp. 342-349, ISSN 1509-3492

- Wilk, M. & Frańczuk, B. (2005a). Rehabilitation of patients after hip arthroplasty using Continuous Passive Motion. *Polish Journal of Physiotherapy*, Vol. 5, No. 1, pp. 8-14, ISSN 1642-0136
- Wilk, M. & Frańczuk, B. (2005b). Local cryotherapy in patients recovering from total knee replacement. *Polish Journal of Physiotherapy*, Vol. 5, No. 3, pp. 329-333, ISSN 1642-0136
- Wilk, M., Frańczuk, B., Trąbka, R. & Szwarczyk, W. (2004). Outcome of early rehabilitation with continuous passive motion for patients recovering from surgical reconstruction of the knee due to degenerative changes. A preliminary report. *Polish Journal of Physiotherapy*, Vol. 4, No. 2, pp. 163-166, ISSN 1642-0136
- Wilk, M., Trąbka, R. & Śliwiński, Z. (2008). Changes in knee joint thermograms following local cryotherapy combined with various physiotherapy regimens. *Polish Journal of Physiotherapy*, Vol. 8, No 3, pp. 267-271, ISSN 1642-0136
- Wilk-Frańczuk, M., Tomaszewski, W., Zemła, J., Noga, H. & Czamara, A. (2011). Analysis of rehabilitation procedure following arthroplasty of the knee with the use of complete endoprosthesis. *Medical Science Monitor*, Vol. 17, No. 3, pp. 165-168, p-ISSN 1234-1010, e-ISSN 1634-3750
- Wilk-Frańczuk, M., Zemła, J. & Śliwiński, Z. (2010). The application of biofeedback exercises in patients following arthroplasty of the knee with the use of total endoprosthesis. *Medical Science Monitor*, Vol. 16, No. 9, pp. 423-426, p-ISSN 1234-1010, e-ISSN 1634-3750
- Wright, A.A., Cook, C.E., Flynn, T.W., Baxter, G.D. & Abbott, J.H. (2011). Predictors of Response to Physical Therapy Intervention in Patients With Primary Hip Osteoarthritis. *Physical Therapy*, Vol. 91, No. 4, pp. 510-524, p-ISSN 0031-9023, e-ISSN 1538-6724
- Zeni, Jr J.A. & Snyder-Mackler, L. (2010). Early Postoperative Measures Predict 1- and 2-Year Outcomes After Unilateral Total Knee Arthroplasty: Importance of Contralateral Limb Strength. *Physical Therapy*, Vol. 90, No. 1, pp. 43-54, p-ISSN 0031-9023, e-ISSN 1538-6724

IntechOpen



## **Recent Advances in Hip and Knee Arthroplasty**

Edited by Dr. Samo Fokter

ISBN 978-953-307-841-0

Hard cover, 452 pages

**Publisher** InTech

**Published online** 27, January, 2012

**Published in print edition** January, 2012

The purpose of this book is to offer an exhaustive overview of the recent insights into the state-of-the-art in most performed arthroplasties of large joints of lower extremities. The treatment options in degenerative joint disease have evolved very quickly. Many surgical procedures are quite different today than they were only five years ago. In an effort to be comprehensive, this book addresses hip arthroplasty with special emphasis on evolving minimally invasive surgical techniques. Some challenging topics in hip arthroplasty are covered in an additional section. Particular attention is given to different designs of knee endoprostheses and soft tissue balance. Special situations in knee arthroplasty are covered in a special section. Recent advances in computer technology created the possibility for the routine use of navigation in knee arthroplasty and this remarkable success is covered in depth as well. Each chapter includes current philosophies, techniques, and an extensive review of the literature.

### **How to reference**

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Magdalena Wilk-Frańczuk (2012). Rehabilitation of Patients Following Arthroplasty of the Hip and Knee, Recent Advances in Hip and Knee Arthroplasty, Dr. Samo Fokter (Ed.), ISBN: 978-953-307-841-0, InTech, Available from: <http://www.intechopen.com/books/recent-advances-in-hip-and-knee-arthroplasty/rehabilitation-of-patients-following-arthroplasty-of-the-hip-and-knee>

**INTech**  
open science | open minds

### **InTech Europe**

University Campus STeP Ri  
Slavka Krautzeka 83/A  
51000 Rijeka, Croatia  
Phone: +385 (51) 770 447  
Fax: +385 (51) 686 166  
[www.intechopen.com](http://www.intechopen.com)

### **InTech China**

Unit 405, Office Block, Hotel Equatorial Shanghai  
No.65, Yan An Road (West), Shanghai, 200040, China  
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元  
Phone: +86-21-62489820  
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](https://creativecommons.org/licenses/by/3.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen